UTC

Utilities Spectrum Assessment Taskforce (USAT) Final Report

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1. Executive Summary

Electric, gas and water utilities and gas pipelines have extensive telecommunications requirements. Expansive, sprawling infrastructure, whether it is transmission lines, water pumps, or electric substations, requires maintenance, remote control and monitoring. These objectives can be met effectively only through telecommunications -- and one of the most critical components in a utility's telecommunications arsenal is its wireless network.

In addition to needing access to wireless communications, utilities have a separate requirement: control over the communications system. This control can be satisfied only through the use of *private* radio spectrum. The transmission and distribution of Gas and Electricity pose unique problems. The two commodities are inherently hazardous and require "real-time" control to effectively administer them. Water systems also require substantial control: loss of water supply to an urban area, community or to the site of a fire could cause disastrous consequences. It also goes without saying that a water main break needs to be addressed in short order. So, while commercial systems may meet *some* of a utility's communications needs, the need for controlled, internal private systems will remain necessary in future years.

Control of the communications system is also very critical during heavy storms and other serious weather events. In these situations, commercial systems become saturated with traffic and, as a result, experience outage. Additionally, because commercial systems provide indiscriminate service to the general public, there is no priority access to the system. Consequently, utilities have no greater likelihood of gaining access to a channel than the average subscriber. It is precisely during these natural weather events that utilities require unencumbered, clear radio channels to address downed lines and other power outage problems. Further complicating matters is the fact that most commercial systems depend upon reliable power to keep their systems running. If power is interrupted, these communications systems will be interrupted also, further impeding progress on power restoration. Private communications networks ensure that utility systems are brought back on line in the most timely manner possible.

The purpose of this report is to develop an estimate of private electromagnetic spectrum that will be required by utilities in the first decade of the twenty-first century. The report is the result of the findings of UTC's Utilities Spectrum Assessment Taskforce (USAT). The task force findings were based on original survey data, projections from historical data and the methodology from the PSWAC (Public Safety Wireless Advisory Committee) process, as applied to utilities and pipelines. The highlights of the report are listed below.

- The total "new spectrum" required (broken into three benchmark dates) is as follows:

Year	2000	2004	2010
Additional Bandwidth Required	1.0 MHz	1.9 MHz	6.3 MHz

- The total "new spectrum requirements" were generated by projecting future applications and growth and then subtracting the spectrum that is currently available to utilities. The total *current* spectrum was calculated to be 2.24 MHz.

- Most survey respondents indicated that there will be an increase in the use of wireless applications and that they will need additional spectrum to accommodate these applications.

- There is considerable interest within the utility community to implement wireless video and wideband data in the future. As technology improves and the cost of terminals decreases, it will become increasingly common for the utility to deploy these technologies.

- The focus of this report is on wireless applications generally used for utility maintenance, control and monitoring. No attempt has been made to separately identify "mobile" versus "fixed" services, per se. For example, applications such as telemetry or supervisory control and data acquisition, are variously deployed on wireless networks that are classified as either "mobile" or point-to-multipoint "fixed" microwave. Spectrum needs for these applications were considered in this study, which confirms the need for additional spectrum for these applications.[1] This study does not, however, consider other fixed microwave needs, such as for point-to-point fixed microwave.

- Future improvements in technology were addressed by the USAT model. As digital modulation and coding schemes become more sophisticated, wireless communication systems will be able to deliver more capacity per unit of electromagnetic spectrum. These improvements are primarily addressed by the "rate" and "err" parameters in the model (see Appendix A and B), both of which show evolutionary improvement over time, accommodating both expectations for new, wide-band services as well as evolutionary technological and FCC "refarming" expectations for more traditional narrow-band services.

- This study accounted for commercial system usage (i.e., commercial paging, cellular, PCS, etc.). As in the PSWAC study, it was assumed that approximately 10% of spectrum requirements for traditional wireless applications would be satisfied by commercial systems in the future.

- The final USAT report is available on the UTC Website at http://www.utc.org/usat.

[1] See UTC Comments and Reply Comments in WT Docket No. 97-81

2. Introduction and Background

Utilities have traditionally made extensive use of wireless applications. These applications include, but are not limited to, traditional dispatch voice operation, telemetry, supervisory control and data acquisition, protective relaying, and pump station monitoring. Utilities will increasingly rely on the wireless communications medium as time progresses.

The purpose of this report is to examine the utility's wireless infrastructure, available electromagnetic spectrum, new technologies, and from this information, develop an estimate of utility spectrum needs through the year 2010.

2.1. About UTC and this report

2.1.1. UTC

UTC was first organized in 1948 as the National Committee on Utilities Radio (NCUR) in order to plan for the use of mobile radio technology in the utility industry. The organization was later renamed Utilities Telecommunications Council (UTC) to better reflect the association's broadened scope of activities and interests. In June 1994, the association was again renamed as UTC, The Telecommunications Association, due to the expansion of the member base to include more than just utilities.

UTC is a non-profit 501(c)(6) "business league" representing the telecommunications interests of entities involved in the generation, transmission or distribution of electricity, natural gas or water. UTC's membership consists of approximately 1,300 utilities and pipelines. Members include large investor-owned utilities, state and municipally organized utilities, rural electric cooperatives, and federal power marketing agencies. UTC is also the Federal Communications Commission's certified frequency coordinator for the exclusive power radio ("IW") channels and maintains the national Power Line Carrier (PLC) database for the coordination of PLC use with licensed government radio services in the 10-490 kHz band.

2.1.2. USAT

The USAT (Utilities Spectrum Assessment Taskforce) project was embarked upon in April of 1997 to determine the amount of new electromagnetic spectrum that utilities and pipelines will need by the year 2010. The methodology of this project draws upon a combination of original survey data, projections from historical data and the methodology from the PSWAC (Public Safety Wireless Advisory Committee)[2] process, as applied to utilities and pipelines.

[2] The PSWAC document is available at http://pswac.ntia.doc.gov/pubsafe/final.htm.

To accomplish the USAT project goal, a steering committee was formed under the UTC Spectrum Management Policy Committee. The final committee was comprised of manufacturers, consultants and end user utilities from the water, gas and electric utility industries. The committee corresponded primarily through teleconference and e-mail and met face-to-face several times in Washington, DC, Alexandria, VA and Portland, OR.

2.2. Utilities Telecommunications

Utility companies are facing a competitive marketplace. The concept of "lean and mean" is becoming the theme of most companies. In an on-going effort to produce utility products at the best price, companies are forced to look for newer high technology methods of improving efficiency in all operating areas. Wireless technology has become a backbone for many trends in automatic meter reading, computer aided dispatch, vehicle tracking, telemetry and numerous other core business support mechanisms. It is apparent that regulatory guidelines must continue to allow the utility industry to improve service and operations, increase overall customer satisfaction and compete fairly in a competitive market.

Spectrum requirements for future years will be heavily dependent on technological developments focused on spectral efficiency. The development of trunking technologies and the release of spectrum in the 800 MHz band provided relief for many utility companies through the 1980's and 1990's. Future applications of wireless technology will rely heavily on this marriage between technology and regulatory flexibility. PSWAC describes the need for advance data and video technologies, both of which are heavily dependent on spectrum usage. Utility companies will require advanced wireless technologies to accommodate a variety of energy and water operational advances. Narrowband and high speed applications will provide utilities with the operational efficiencies demanded in the future.

It is imperative that utility organizations and regulators encourage the development of spectrally efficient technologies that provide the best possible service to the general public. Even spectrally efficient technologies will, however, continue to require additional spectrum allocations for successful implementation.

2.2.1. The Utility and Wireless Applications

The following paragraphs will illustrate the focus of the USAT: wireless applications within the utility operations context.

2.2.1.1. Voice

Voice communications will continue to play a critical role in every day utility operations for some time into the future. Voice requirements, though, will probably not change as dramatically as requirements for data and video communications. Voice requirements will be dominated primarily by forces such as labor force distribution and less so by technology. Various concepts in wireless voice communication are discussed below.

<u>Dispatcher to Crews</u>

This is a typical communications path between dispatchers and field personnel. The call types are typically business oriented with emphasis on operating the business in a safe and efficient manner.

Crew to Crew
This function relates to the typical communications between field users. These communications are used for the coordination of daily activities to maximize the safety and efficiency of operations.

Emergency Call
This function is typically initiated from a field user to a dispatcher. As the name implies, the call type is that of an emergency where loss of life or property is imminent or has already taken place.

"Talk Around"
In many operations between field users, routing a call through the network or a repeater is not feasible for reasons such as access delay or being out of range of the system. A talk around mode is necessary so that the field users can communicate with each other, within the range of their mobiles and portables, without the assistance of a network or repeater.

Interconnect
In nearly all field activities, users have a need to communicate with people by way of landline telephones. Telephone interconnect is a necessary option for many of the present day radio systems.

Trunked Operation
Traditionally allowed only in the 800, 900 and 220 MHz bands, trunked operation is now permitted on channels below 512 MHz. While the issue of channel exclusivity must still be reconciled, trunked operation in this band may be sought after and provide for efficient use of spectrum. Trunked operation involves the dynamic allocation of channels. When a channel is requested (via a control channel), a computer searches for an available frequency pair and assigns it to the party requesting it. This eliminates scenarios in which many users are waiting for a channel while other channels remain idle, as in conventional systems.

Mutual Aid/Interoperability
Utilities will need to communicate with adjacent utilities or local public safety or civil defense authorities in emergency situations, or with other utility crews brought in to assist with restoration efforts. In the wake of deregulation, the utility industry will become increasingly fragmented and, with more parties involved, interoperability will become a critical consideration.

1.2.2.1.1. Typical Voice Channel Usage in a Utility

Below are two plots depicting how a typical voice radio channel is loaded in a weekly utility operation. The first plot is a "typical week" in the life of a voice radio channel. The second, and more significant plot, represents loading under storm conditions. Because storm conditions, and other emergency conditions, are the most demanding on radio systems, spectrum requirements should be calculated based on these conditions. The data was extracted from a 15-channel trunked system. The total time is an aggregate of these 15 channels, so values do exceed the total number of seconds in a 15-minute period.

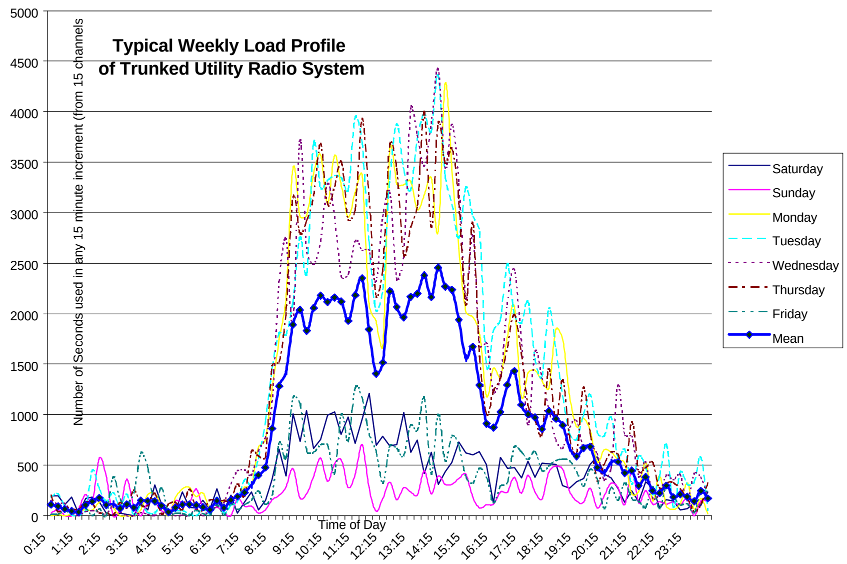


Figure 1

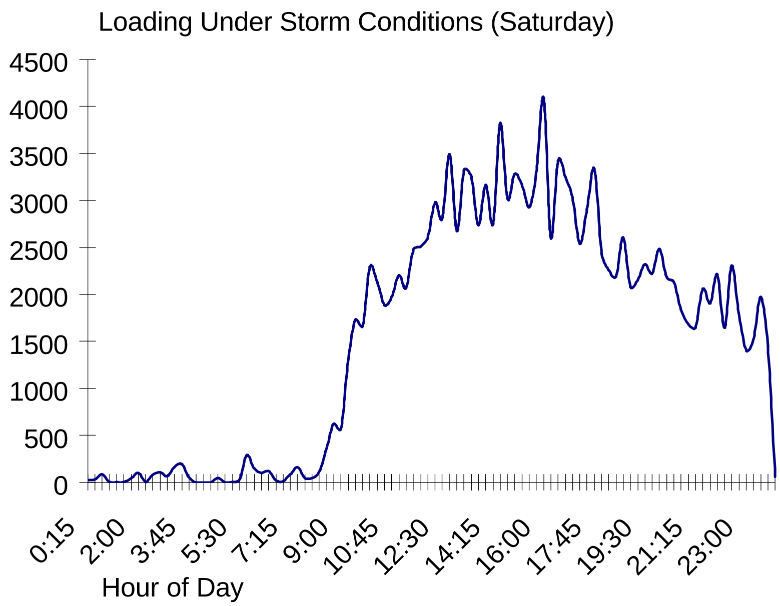


Figure 2

2.2.1.2. Data: System Monitoring and Control, Reports and Status Messaging

The efficient operation and coordination of power, water, gas and steam is totally dependent on the effective use of data communications. Large transmission and distribution networks that are spread over vast areas require remote administration. Data applications bring necessary control and status information to system operators' fingertips.

As electric loads have increased and generation plants have become increasingly removed from the distribution market, data communications have become paramount to efficient system operations.

Telemetry, Protective Relaying

The utility industry relies on data communication systems for the purposes of controlling electrical distribution systems and pipelines which include gas, steam, and water. Electrical distribution systems utilize these data links to trip circuit breakers in the event of a power fault or short circuit. They also utilize these systems to control the amount of load, which the generation facilities have to serve during peak demands. The pipeline systems utilize similar techniques for the purposes of controlling valves to reroute or inhibit the flow of materials in the event of a failure of section in a pipeline network.

SCADA (Supervisory Control And Data Acquisition)

Supervisory Control And Data Acquisition (SCADA) systems are generally computer-controlled radio communications links that provide for the remote administration of facilities. These systems allow a user to control and monitor equipment without having to deploy staff where the equipment is located. Additionally, they provide for very fast monitoring: usually the master can poll all remotes in a matter of seconds. These systems are point-to-multipoint networks usually configured in a "star" architecture. In each area, one "master" station communicates with multiple Remote Terminal Units (RTUs) usually in the 450 or 900 MHz band of the electromagnetic spectrum.

As modern utility systems have increased in complexity, SCADA systems have become critical components of infrastructure. These systems help to automate tasks like opening and closing circuit breakers, monitoring system stability and monitoring alarms for overload conditions. Additionally, they are used for monitoring and controlling pumping stations and other critical components of water networks.

Automated Meter Reading

Increasingly, utilities are turning to wireless technologies to read meter data on the consumer's premises. This is generally accomplished with a mobile architecture or a fixed network. The mobile system employs a handheld unit or a van mounted unit, which polls consumer meters (typically with a licensed frequency) and "wakes" the meter unit. The remote meter unit then sends metering data back to the mobile unit (generally on an unlicensed frequency). The fixed network architectures generally use a pair of licensed frequencies. These systems operate in a manner similar to the mobile system except that there are numerous "mini-master" stations deployed to interrogate meters.

Home Automation

A promising future data application is that of home automation. This service will allow appliances to be monitored or controlled from a remote location. This may allow consumers to turn on lights, sprinklers, air conditioning units, etc. from a remote location. It may also enable a utility to monitor wasteful appliances and alert consumers how to better manage electricity consumption.

Security

Other common data needs include security system monitoring systems. As with many other entities, security systems are essential to help protect lives and property from destruction or tampering by individuals.

Mobile/Personal Data Computer/Terminal Applications.

In order to maximize the effectiveness of personnel in the field, a mobile office environment utilizing wireless data communications must be developed. This mobile office would provide instantaneous voice, data, and video access to other utility personnel, various utility data repositories, personnel from other utility related disciplines and commercial networks. At some point, utilities may incorporate these mobile offices into a paperless environment inclusive of multimedia transfer.

A need exists for real-time support of wireless mobile and portable computer systems capable of transmitting and receiving routine data queries and responses, electronic mail, location data and other graphics including equipment schematics along with incident-specific data.

A need also exists for communications support of wireless mobile and portable computer systems capable of transceiving incident specific data and intelligence. Support for these systems should accommodate: the transmission of text, such as electronic mail; secured and unsecured individual and group messaging; multilayered geographic information data (GIS); and real time data, such as automatic vehicle and personnel location, weather and atmospheric conditions, hazardous material or environmental/equipment conditions and incident intelligence received from remote sensors or directly keyed.

Wireless LAN/WAN Connectivity.

Typically operating in the unlicensed 2400– 2500 MHz band and infrared regions of the electromagnetic spectrum, the wireless LAN allows one the freedom to roam while maintaining connectivity to a LAN. A transceiver and antenna interface attaches to a personal computer and allows it to connect with a LAN without having to run cable to it.

Geographic Position and Automatic Location Data.

Utilities require the ability to transmit location data, determined by geographic position technology or other means, automatically or on demand, to other locations. Examples of this need include constant updating of vehicle positions for dispatch and worker safety purposes, constant updating of individual worker location for safety purposes when the worker is outside of her/his vehicle, and the ability to trigger position transmitting devices on stolen construction or other heavy equipment.

A need exists for automatic communication of location information generated to report accurate location of vehicles and personnel into a synthesized computer command and control system. This system should also accommodate associated data, such as emergency situation alert function, personnel vitals and equipment status and needs such as fuel and water. Automatic location information will accomplish several goals in the mission of life and property protection: emergency responders dispatched with regard to actual incident proximity will trim precious life and property-saving response times; incident supervisors will accurately assign and monitor units/personnel to accomplish strategic efficiency; and emergency field personnel will report emergency situation location by the push of a button, speeding help their way and reducing the likelihood of injury or death.

Location systems provide a means to track crews and equipment for the purposes of effective response to disruption of service as well as for efficient day to day fleet management. When a catastrophic event does occur, the Utility entities rely on access to databases which contain information concerning the availability of repair and restoration materials and equipment.

Transmission of Reports.

This system should accommodate transmission of forms and reports to central sites from mobile and remote locations. This capability will be used to transmit service or work orders to central locations in long data streams of up to several seconds. This capability will reduce paper transactions, increase worker field time, and speed transmission of vital information to command and administrative staff.

Remote Device Monitoring.

Utilities require the ability to monitor remote device indicators via data transmission. For example, the real-time ability to monitor air quality standards at chemical and nuclear incidents is needed to help establish evacuation plans. Data transmission capabilities must support transmission of wind speed and direction, temperature, and a time and date stamp. The data bank of remote device transmissions must be accessible by remote computer or terminal for incident tracking and decision-support by field personnel.

Robotics support.

In extremely hazardous situations, safe access may only be accomplished with remote equipment supported by robotics. Hazardous material containment may only be accomplished with remote equipment supported by robotics. The operation of this equipment will be heavily dependent upon wireless data connectivity.

Commercial Services

Cellular Digital Packet Data (CDPD) is a commercial service that many utilities have considered for their data communications needs. This architecture utilizes idle voice channels in the commercial cellular network. Using 30 kHz voice channels in the 800 MHz cellular band, the data transmissions are subordinate to voice transmissions. When a voice transmission is initiated, the data will be rerouted to another channel.

2.2.1.3. Wide Band Data and Static Imaging

Still-Photographs

Utilities require the ability to transmit still photographs on demand to other locations. For example, a worker in the field should be able to transmit a digital image of a critical circuit element, construction detail or possible safety situation to a remote location upon demand.

GIS/Map Data and Technical Diagrams

GIS (Geographic Information Systems) are becoming increasingly prevalent in Utility operations. GIS systems allow for the accurate combination of general map data with system specific infrastructure. Discrete landmarks can be pulled up from a computer database and displayed graphically on a map on a computer screen. Users can easily see the precise location of transmission towers, transformers, company buildings, etc., on a street map. GPS (Global Positioning System) receivers now facilitate the population of GIS databases, by allowing for the quick determination of accurate coordinates for various infrastructures (e.g., transmission towers, radio towers, transformers, etc.). Real time wireless access to this information will be necessary for the utility of the future.

Additionally, Electronic documentation and the "Interactive Electronic Technical Manual" will become increasingly pervasive in the future. Real time access to these resources will be necessary and will require wideband channels to accommodate complex diagrams and the accompanying links/text.

2.2.1.4. Video

Utilities are continuously looking for new techniques to lower customer minutes of interruption. Storms and natural catastrophes are a major source of distribution and transmission line outages which cause these customer interruptions. Real time video is one such technology that would greatly enhance a utility’s ability to expedite damage assessment. During wide spread outages video cameras mounted on helicopters would provide accurate assessments of damage location and ensure proper crew and vehicle deployment. Utilities currently deploy crews based on limited information, not always understanding the type or extent of the damaged facilities. Real time video feedback to operation centers would help facilitate restoration of power in the shortest time possible.

There is also a strong and developing need for wireless video services to enhance daily operational efficiencies and to deal with emergency conditions where it is important to communicate the complex and often dynamically changing details of the situation to others in the command or worker/supervisory chain. Video systems are very valuable tools when Public Service entities respond to catastrophic events such as train derailments, tornadoes, hurricanes, as well as earthquakes; for example, ice storms such as the one that hit upstate New York in the winter of 1998 caused thousands of lines to go down. Video images of disaster areas sent from the field would have greatly assisted with power restoration efforts.

The basic requirement for video/imagery is immediate, clear wireless transfer for all utility personnel upon all demands, major and minor, created by utility-related field situations and emergencies. Video/imagery capture and display systems must be capable of transceiving specific replications and should accommodate video and imagery from multiple sources including privately owned and utility controlled. For example, automatic aid agreements with public safety agencies could often require quality video/imagery of incident scenes for utility command personnel, either directly or through retransmission.

As an extension of the data related security monitoring systems above, video surveillance provides much more information in specific situations than typical alarms can provide. In many cases, the video surveillance would be most effective if made available through a wireless means instead of via wireline.

Multiple departments may need to be able to monitor video transmissions, but the ability to access utility video must be based on a “need to know” or incident management basis. Certain situations may require encryption of the video stream in order to preclude casual monitoring.

<u>Incident Video.</u>

Some incidents, like repairs to sensitive areas of a nuclear power plant or emergencies, require real-time video. While these incidents may be infrequent in some areas, others will have a more frequent demand for real-time video. The capability must exist for both point-to-point and broadcast use of the video. For example, full motion video must be transmitted from the incident scene to either an incident command post or to a remotely located emergency operations center. Hurricanes, major fires, chemical/nuclear incidents, etc., may require monitoring of the incident from more than one location. A specific need exists for the real time transmission of Haz Mat scenes from the incident location to the incident command post and also to remotely located emergency operations centers.

Surveillance and Monitoring.
Utilities require the ability to transmit video snap shots at the rate of approximately one frame every 5 seconds for surveillance and monitoring purposes. For example, sub-station surveillance and building security would be adequately served by this quality of video transmission.

Aerial Surveillance Video.
Many utilities need to operate surveillance of major transmission lines or emergencies such as natural gas explosions or ruptured water mains and other events from airborne platforms. Also, a need exists for the transmission of video/imagery and multi-spectral toxic cloud replication. Full motion video transmissions from airborne platforms to both command and control locations and supervisors on the ground is required.

Robotics Video.
Electrical safety, hazardous material and explosive conditions frequently benefit from use of robotic devices. Full motion, generally short distance (up to 1000 meters), video transmissions from the robotic device to a local control site is required to support such robotics activities.

In extremely hazardous situations, like those involving nuclear facilities, repairs may only be accomplished with remote equipment supported by robotics. Also, in these extremely hazardous situations, hazardous material containment may only be accomplished with remote equipment supported by robotics. The operation of this equipment will be heavily dependent upon wireless connectivity and the ability to guide these devices via video support.

Slow-Scan Video
In many circumstances, the real time nature of full motion video is not required. In these circumstances and, in the absence of high bandwidth video channels, slow scan video can be utilized. This form of video involves transmissions where the picture is updated at a much slower rate than that of full motion video.

Worker Safety and Operational Video Transmission.
Utilities would benefit from trucks and vehicles being equipped with mobile video cameras, with both a local recording and wireless transmission means. High quality video recorded by these cameras would provide evidence usable in civil liability trials, and documents worker actions in the event professional standards concerns are voiced. The ability to transmit both “slow-scan” and full motion video from mobile video cameras directly to dispatch and other command and control installations is required on demand. Although constant transmission of this data from each individual worker or mobile unit is often not required, the ability to monitor video from a unit is needed on an episodic basis in the event of worker assistance situations and other high risk events, or operations of high command interest. In addition, the system must support retransmission of full motion video to mobile and remote locations,

where command and control personnel and other mobile workers can monitor, perform decision-making and provide assistance based on the video transmission.

2.2.2. Why Private Systems?

Private telecommunications systems are generally defined as those systems that support a company's internal communications requirements (e.g., directing a group of employees to work assignments in a dispatch radio system). They are to be contrasted with "commercial" wireless systems. Commercial systems are defined as those which 1.) provide telecommunications service for a profit, 2.) are interconnected to the public switched telephone network (PSTN), and 3.) are offered indiscriminately to the general public.

Private systems are critical to reliable and efficient operation in the utility industry. Commercial systems can (and do) provide some of a utility's telecommunications requirements. However, two substantial issues prevent commercial entities from providing all service: a.) The need for System Control, and b.) Unique design requirements.

2.2.2.1. The Need for System Control

Because of the unique nature of electricity, gas and water, reliability and control are of critical importance. To prevent disaster, it is imperative that communications systems remain functional and accessible during storms and other natural events.

During heavy storms and other emergency situations, commercial systems become saturated with traffic and, as a result, experience outage. Additionally, because commercial systems provide indiscriminate service to the general public, there is no priority access to the system. Consequently, utilities have no greater likelihood of gaining access to a channel than the average subscriber. It is precisely during these emergency situations that utilities require unencumbered, clear radio channels to address downed lines and other power outage problems. Further complicating matters is the fact that most commercial systems depend upon reliable power to keep their systems running. If power is interrupted, these communications systems will be interrupted also, further impeding progress on power restoration.

UTC surveyed members on the reliability of commercial systems in the context of storms and other natural disturbances. Some of the responses are listed below:

Event	Public/Commercial System Response	Private System Response
Hurricane Fran, September, 1996, North Carolina	Leased lines (used for SCADA) experienced complete outage. Commercial Cellular system -- congestion at first, later complete outage because of lack of back up power.	No disruption. Private system remained in service throughout the event.
Ice/Snow storm, October,	Leased lines experienced complete outage.	No disruption. "We

1996, Kansas City	Bad congestion on cellular system and voice telephony system.	have private communications for radios, internal voice telephone, and data. Our private system is what we relied on." "Customer service operations were in big trouble for voice dial-in service."
Flood, December, 1989, Malaga, Spain	Complete outage of all commercial systems.	No disruption.
"Normal day," Centerville, IA	12 hour disruption in long distance and leased lines	No disruption.
Ice storm/Blizzard, Fergus Falls, MN	Caused congestion on cellular system.	VHF radio system became very busy. One repeater tower was lost. Company moved repeater to a wood pole.
Hurricane Andrew, South Dade County, FL	All commercial systems were disrupted. "Extensive outages followed by congestion failures and blocking." Large impact on company operations, "notably loss of all communications to Turkey Point Nuclear plant."	"Lost tower at Turkey Point, miles of OPGW fiber downed with poles. Congestion on conventional LMR."
Ice Storms, New York State, January, 1998	"Thousands of cellular phones were deployed in the area. Overcrowding becomes an issue during emergencies. Compounding the problem was the fact that many cellular tower sites were without electricity and no backup means of power. Once a Cellular tower is "off the air", calls must be re-routed to new sites which may not be close by the person making the call. The result was even more crowded Cellular systems. Through the cooperative efforts of NMPC's Regional and System Meter and Test and our I.T. Telecommunication group, both Cellular carriers were able to install additional sites in the storm area. NMPC's tower site at Main Ave in Watertown, became an almost instant new cellular site. This increased capacity immediately helped to alleviate the crowding problem. As the restoration progressed, cellular phones were used extensively to transmit vital information	"In areas where there is normally less than a hundred crews and where radio channel activity is limited to approximately 30 minutes or less per hour, this storm brought over a thousand crews engaged in hundreds of activities. Radio dispatching and vehicle conversations kept our systems busy for 50 minutes or more per hour"

	to crews and between storm management in the field. "	

From these responses it is clear that private communications systems play a pivotal role in storm and emergency situations.

2.2.2.2. Unique Design Requirements (Service Coverage and Service Availability/Response Time, System Stability)

One serious shortcoming of commercial service providers is that they often do not provide service throughout the utility service territory. For example, a cellular operator may deem it unprofitable to deploy sites in remote areas where usage is likely to be little if not nonexistent. Utilities still require reliable wireless service in these areas.

Another shortcoming of commercial systems is that they may not be designed to the exacting tolerances required in the daily operation of a utility system. Often response times of milliseconds are required to avert disasters catastrophic in nature. For example, high-speed teleprotection systems require 20 ms or less response times. Many event monitoring systems require a resolution of 1 ms. Short term (or long term) system outages are not acceptable. Commercial systems, designed for voice traffic, may not be designed to these robust standards required by utilities.

A general overview of private radio can be found in the Wireless Telecommunications Bureau's white paper entitled "Private Land Mobile Radio Services: Background." It can be downloaded from the FCC's web site at: http://www.fcc.gov/wtb/whtepapr.pdf.

2.2.2.3. Influence of commercial systems on private needs

As indicated above, utilities do use commercial cellular type systems (i.e., cellular, PCS or ESMR) to augment their voice systems. Commercial data systems are also employed. While these services can add to utility communications, it is highly unlikely that they will be able to serve as a replacement for the private dedicated utility system.

This study accounted for commercial system usage. As in the PSWAC study, it was assumed that approximately 10% of spectrum requirements would be satisfied by commercial systems in the future.

2.2.3. Restructuring of the Electric Utility Industry in the United States

Driven largely by industrial customers, electric utility restructuring is already unfolding in a number of states. Restructuring is often labeled "deregulation," which is a misnomer because there will still be a great deal of regulation when the smoke clears. It is perhaps better labeled "reregulation," since regulation will be redesigned and redistributed, but still pervasive.

2.2.3.1. What is Restructuring?

Restructuring is essentially the transition from "vertically integrated" monopolistic electric service to competitive service. To discuss restructuring, one must first look at how a traditional utility is structured.

Generally, there are four functional units within an electric "utility":

1. Generation;
2. Transmission;
3. Distribution;
4. The Customer Information Unit.

The generation unit converts some resource (e.g., oil, coal, nuclear fuel, air flow, water flow, etc.) into electrical energy. Electric power does not generally lend itself to efficient storage, so the amount of generation will be based upon expected demand.

The transmission unit carries the electricity that has been generated to areas where it will be utilized. Often the source of generation, a dam for example, is far removed from the end user. To effectively carry power long distances, it is necessary to use high voltage transmission lines.

The distribution side of the utility lowers the transmission voltage to practical usable voltages and delivers the electricity to the end user.

The forth category, the customer information unit, is the interface with the customer providing metering and billing for the use of the electricity.

Prior to restructuring, the above operational units usually fell within the control of a single company, i.e., the "utility." In a restructured environment however, some, if not all, of these constituent parts will be separated and operated by independent entities. Additionally, new entities may be created. For example, California has developed a system that includes an Independent System Operator (ISO). This non-profit company will be employed as an independent manager of the transmission network. It will ensure equal access to the transmission grid by all generators. A power exchange (PX) will also be employed in the California system. The PX will act as a broker for bulk power.

To get a better sense of California's restructuring plan, visit the California Energy Commission's Restructuring Web site: http://www.energy.ca.gov/restructuring. Another comprehensive Web site on restructuring is the U.S. Energy Information Administration's Restructuring site. The URL is: http://www.eia.doe.gov/cneaf/electricity/page/at_a_glance/restruct.html

2.2.3.2. How will Restructuring impact telecommunications?

Telecommunications will still be an integral part of utility operation after restructuring has taken full effect. It will still be necessary to reliably control the vast network of deployed electric networks. In fact, a greater need for wireless communications may exist due to reduced staff. As the industry becomes decentralized and power sources become increasingly dispersed, precision control systems will become critical. Additionally, automated processes and remote access will become more prevalent. These will be practicable only to the extent that communications infrastructure can support these applications.

To survive in a competitive environment, the new utility will need to keep costs to a minimum. As a result, some communications requirements will likely be outsourced. However, the utility will still require extensive private communications to support its critical infrastructure.

3. The Utilities Spectrum Assessment Taskforce (USAT) Project

3.1. Surveys

3.1.1. Steering Committee Survey

A detailed survey was developed for steering committee members to complete. After formally answering the questions on this survey, steering committee members were able to determine the shortcomings and ambiguities of the instrument. This feedback was then applied to the final survey.

3.1.2. Final Survey

The final survey was formulated using comments from those who had taken the steering committee survey. It was to be more user friendly, shorter and generally more to the point than the steering committee survey. Once completed, it was forwarded to UTC's Wireless and Frequency Coordination Sections. Additionally, it was sent to a number of additional water utilities with the help of American Water Works Association (AWWA). A total of 94 surveys were completed and returned to UTC.
Charts indicating the demographics of the respondents and some highlights of the survey results follow:

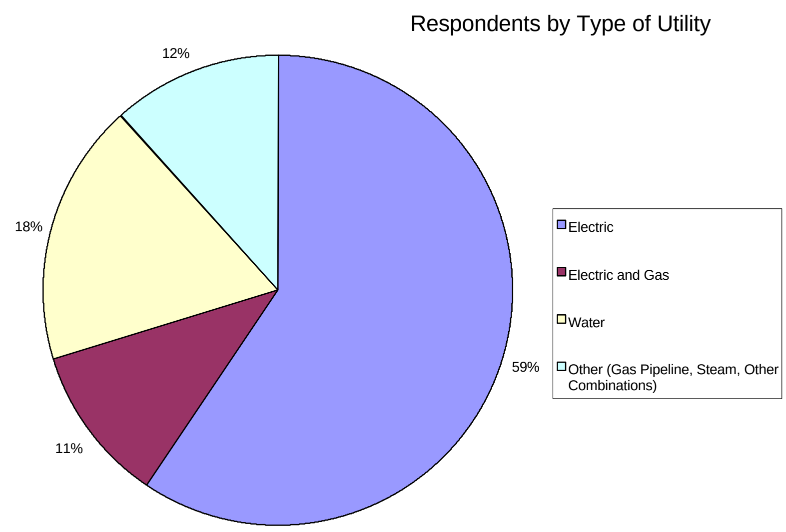


Figure 3

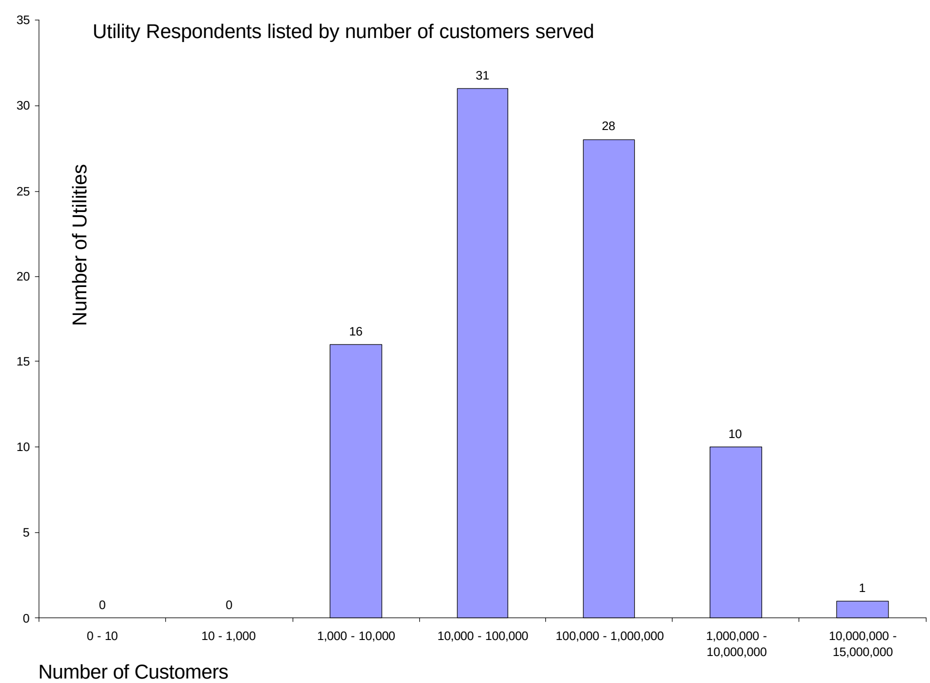
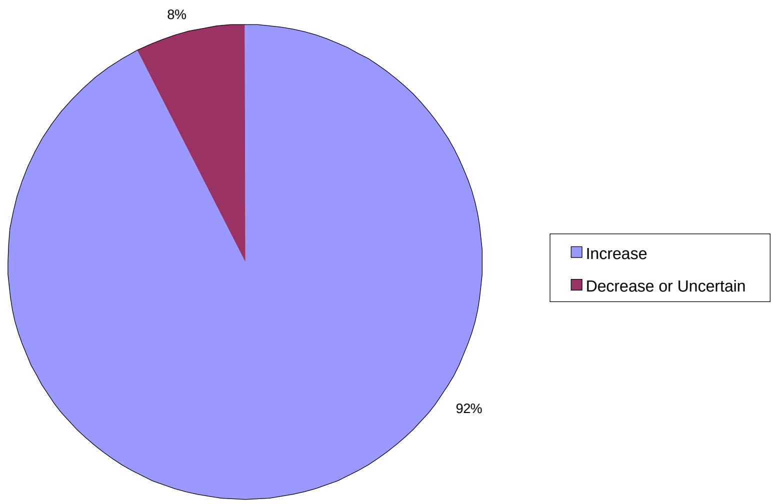


Figure 4

As shown above, over half of the respondents were electric utilities. Additionally, most of the respondents serve between 10,000 and 1,000,000 customers.

Figures 5 and 6 below indicate that an overwhelming majority of the respondents to the survey believe that there will be an increase in the use of wireless applications and that they will need additional spectrum to accommodate these applications.



Answers to "In general, do you foresee an overall increase or decrease in the use of privately owned, internal wireless applications (voice, data, video, etc.) in your company in the next ten years?"

Figure 5

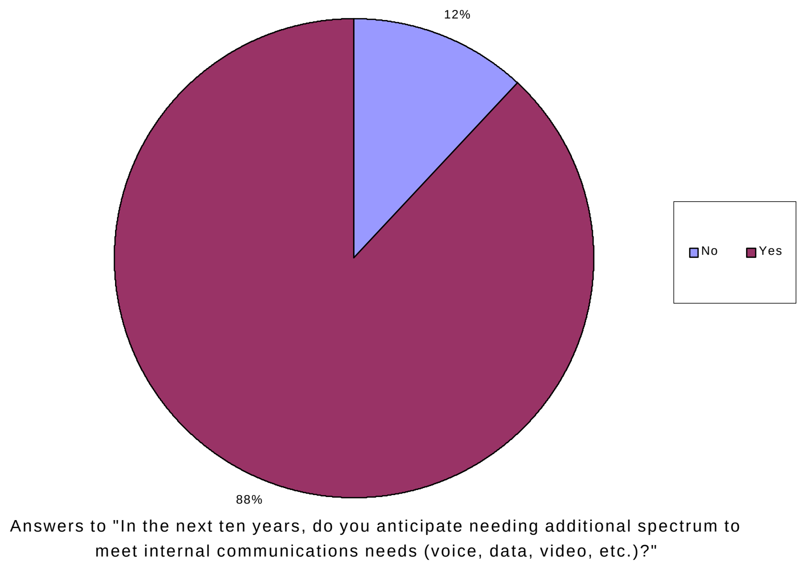


Figure 6

The following figures show that there will be a considerable demand for wireless wide band data and wireless video. These technologies are gaining momentum and should be nearing maturity by the middle of the next decade.

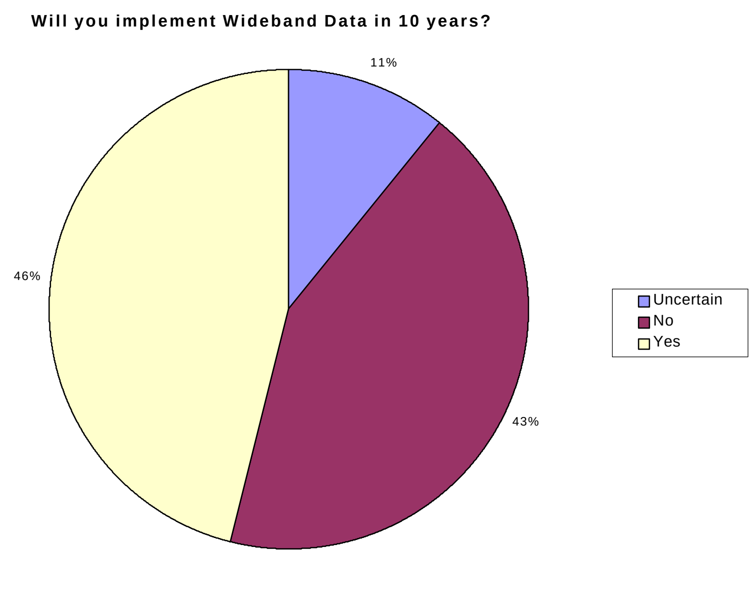


Figure 7

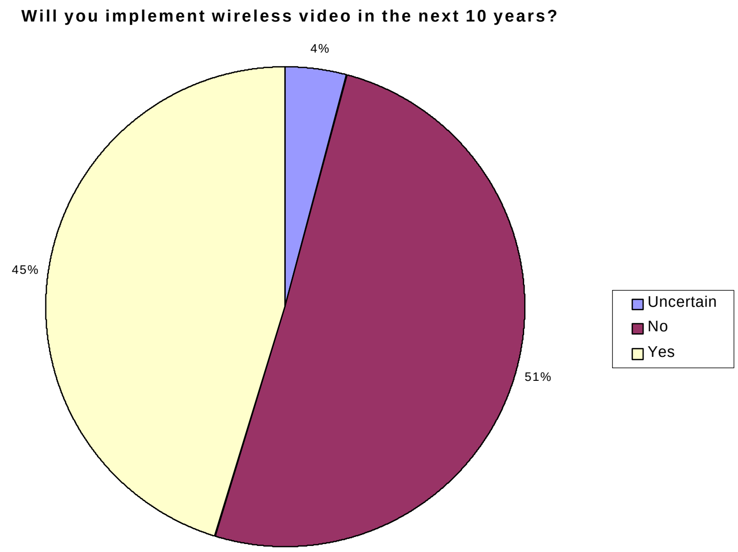


Figure 8

Figure 9 below shows that almost all of the respondents predict an increase in voice loading, and many predict a substantial increase.

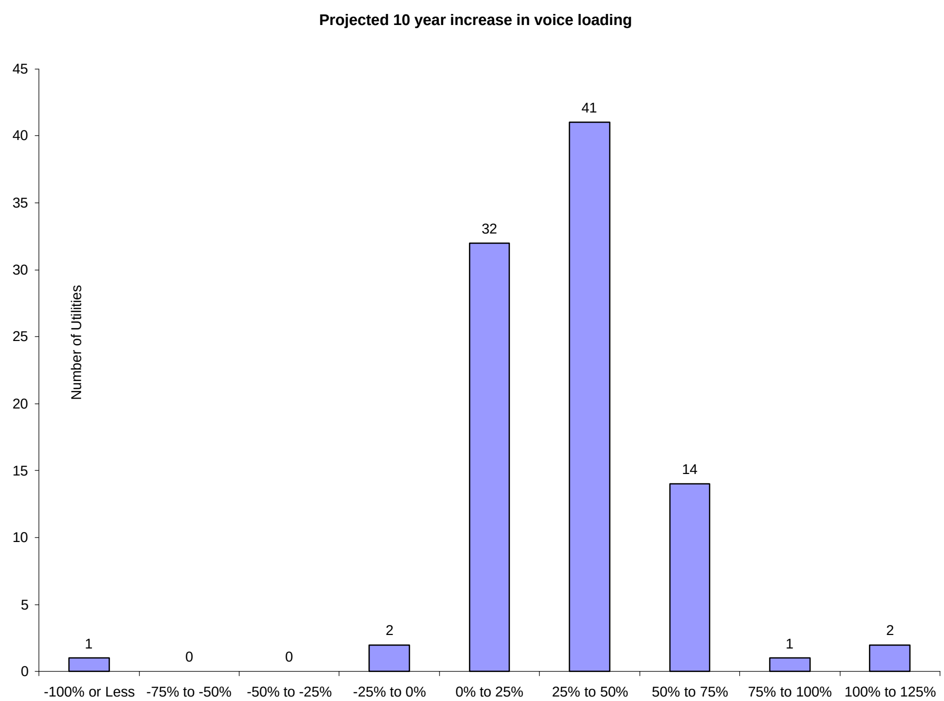


Figure 9

3.2. Linear Projection of Spectrum Needs from Historical Data

As further input into the process, a simple extrapolation of license demand was performed. Licensee data was taken from FCC reports and extrapolated to the year 2010. Using transmitters as the index, a 255% growth was experienced between 1984 and 1994. Extrapolating this data from 1994 to 2010, a 100% increase in the number of units is projected. While improvements in technology are likely to reduce this value, it is clear from this data that the use of wireless will likely increase and that the increase will be dramatic. The figures below show actual data points (recorded by the FCC only up until 1994) and extrapolated data based upon a linear growth factor.

Year	Linear Projection of Transmitters	Actual Number of Transmitters
1984	317444	300231
1985	364249	364728
1986	411055	415902
1987	457860	456660
1988	504666	524366
1989	551471	557270
1990	598276	574873
1991	645082	665740
1992	691887	706490
1993	738693	731369
1994	785498	768551
1995	832303	
1996	879109	
1997	925914	
1998	972720	
1999	1019525	
2000	1066330	
2001	1113136	
2002	1159941	
2003	1206747	
2004	1253552	
2005	1300357	
2006	1347163	
2007	1393968	
2008	1440774	
2009	1487579	
2010	1534385	

Figure 10

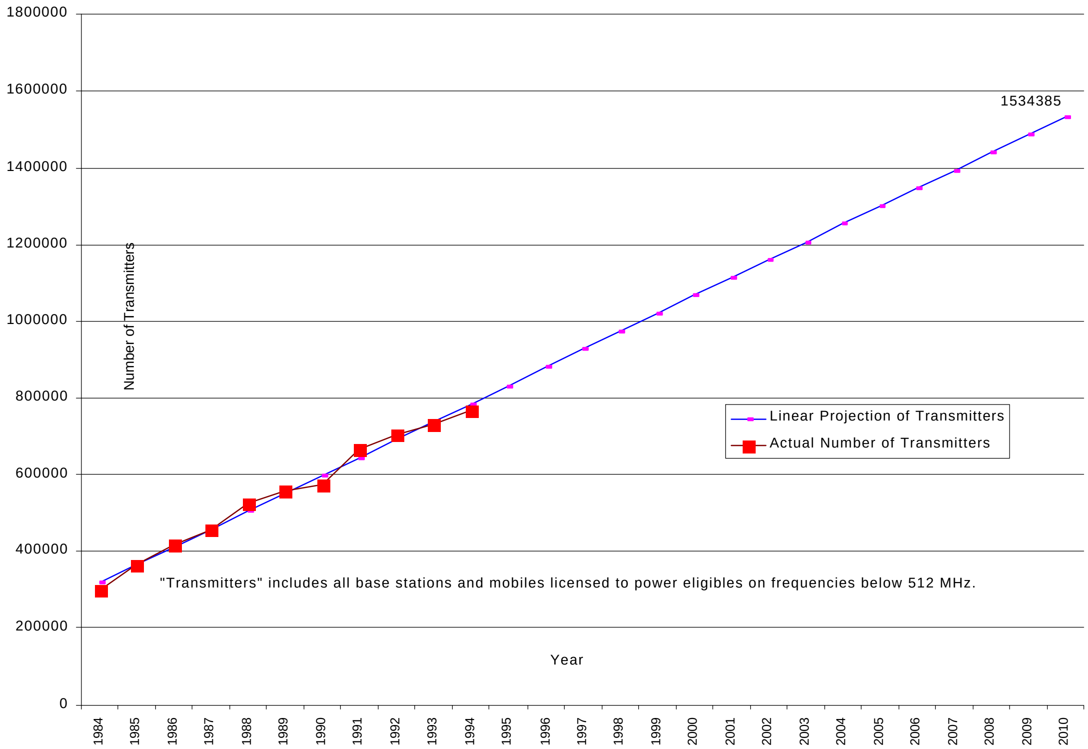


Figure 11

3.3. Empirical Model: Los Angeles County

The USAT task force decided that a specific urban area should be examined to determine the final spectrum requirement. Los Angeles County was chosen primarily because of its size and density of users.

The total number of utility employees for the county was obtained from United States Census data. From USAT survey data and previous market studies, a 66% voice radio penetration rate was applied to the employee count. Then, a 4% annual growth rate in voice radio usage was applied. As in the PSWAC study, wide band data and video projections were indexed on voice usage. From the USAT survey, it was determined that utility users would fall into the "heavy" usage category of both wideband data and video. This produced values of 27.33% of voice penetration for wide band data and 17% of voice penetration for video. Because these technologies are not yet mature, the penetration values were scaled back in the projection for the year 2000.

The amount of "current" spectrum available to utilities was subtracted from the "projected" spectrum requirements. The value for the current spectrum was calculated to be 2.24 MHz. The methodology for this calculation is included in Appendix A.

The spectrum projections were broken into three benchmark dates: 2000, 2004, and 2010. The projected spectrum requirements, less current power spectrum, are listed in the table below:

Year	2000	2004	2010
Bandwidth Required	1.0 MHz	1.9 MHz	6.3 MHz

The complete results of the Los Angeles projection are attached in Appendix B.

4. Conclusion

Utilities rely heavily on the use of private wireless systems for voice and data applications. The need for private wireless spectrum available to utility users will only increase as we transition from the twentieth to the twenty-first century. A total of 6.3 additional MHz will be needed by the year 2010. In addition to increased voice requirements, two other applications will increase the need for spectrum: wideband data and wireless video. These two developing technologies will play an increasingly important role in the operations of today's utility and the utility of the twenty-first century.

Appendix A: Methodology and Definitions

General Definitions

The formula used to calculate bandwidth was the PSWAC study equation, that is:

$$\text{Required Bandwidth (MHz)} = \frac{\text{Erlangs Per Unit X No. of Units X SRC X 10}}{\text{COD X Rate X Load X Reuse X (100-Error)}}$$

where:

Erlangs Per Unit: A measure of traffic load, or the time that the user transmits on a channel, expressed as a ratio between 0.0 and 1.0. With 1.0 erlang the user transmits all the time and with 0.0 erlang the user never transmits. The Erlangs Per Unit is that factor averaged over all of the transmitters being considered.

No. of Units: The number of transmitters within the geographic area being considered that are in service over the time under consideration.

SRC (Kbps): The content of the source message to be transmitted is represented by the shortened form SRC. All messages are in digital format, and the units are kbps, (kilo-bits-per-second).

COD: This is a dimensionless factor of improvement in coding of the message into bits to be transmitted. This improvement will take place between now and the date for which the computation is made.

Rate (b/s/Hz): The rate at which data bits are transmitted over the air by the transmitter in each Hz of its RF channel bandwidth. The units are b/s/Hz, (bits-per-second-per-Hz).

Load (%): The average percent of time that the channels are occupied by a transmission from a user.

Reuse: The number of times the same RF channel is reused within the geographic area under consideration.

Error (%): The average amount of error coding and overhead that is applied to the digitally formatted message before transmission. With 0% coding there are no bits added to the message, and with 50% coding, half of the transmitted bits will be dedicated to overhead, error mitigation and correction.

Current Spectrum Allocated to Power (IW) Users

The primary focus of this report was on Part 90 "mobile" spectrum. Consequently, the "current spectrum allocated to power users" was based entirely on channels allocated in Part 90. This assessment did not consider Part 101 "fixed" microwave spectrum.

To best gauge the amount of "IW" (power) spectrum, pre-refarming channels were analyzed. In the VHF/UHF bands, the bandwidths of the exclusive IW channels were added together to yield 0.565 MHz of spectrum.

800/900 MHz spectrum proved more difficult to evaluate because utilities do not have their own "pool" within the 800/900 MHz band, but rather are part of the more general Industrial/Land Transportation pool. To determine the amount of "utility" spectrum in this band, a 35-mile radius search was performed about the center of the City of Los Angeles for all Industrial/Land Transportation entities in the 800 and 900 MHz bands. These records were then analyzed to determine which licensees were utilities. After separating the utilities from the non-utilities and accounting for duplicate records, 1.68MHz of 800/900MHz utility spectrum was calculated.

Adding the VHF/UHF spectrum (0.565 MHz) to the 800/900 MHz spectrum (1.68 MHz) yielded the total current mobile spectrum available to utilities: 2.24 MHz.

Improved Future Technology

Future improvements in technology were addressed by the USAT model. As digital modulation and coding schemes become more sophisticated, wireless communication systems will be able to deliver more capacity per unit of electromagnetic spectrum (Hz). These improvements were addressed by the "rate" and "err" parameters in the model.

"Rate" is expressed in the units of b/s/Hz (bits-per-second-per-Hz), and is defined as the rate at which data bits are transmitted over the air by the transmitter in each Hz of its RF channel bandwidth. Clearly, as systems become more efficient, the rate will increase. Thus, there will be more bits-per-second for the same 1 Hz of bandwidth. Today, for example, a typical digital radio operating on 12.5 kHz channel, operates at a throughput of 9.6 kbps (e.g., 4.8 kbps VSELP added to 2.1 kbps Error Correction Coding and 2.7 kbps Embedded Signaling). 9.6 kbps divided by 12.5 kHz yields 0.768 kbps/kHz. This reduces to 0.768 bps/Hz. In the USAT model, the rate values .75 for voice and data and 2 for wideband data and video were employed for the year 2000. By 2010 these values increase to 1/1.5 and 3.5 respectively.
The "err," or "error," parameter is defined as the average amount of error coding and overhead that is applied to the digitally formatted message before transmission. With 0% coding there are no bits added to the message, and with 50% coding, half of the transmitted bits will be dedicated to overhead, error mitigation and correction. This parameter will probably improve in future years. "Improvement" will yield a smaller value -- less coding with greater throughput. In the USAT model, the err factor was set at 54% for the year 2000 and improved to 50% by the year 2010.

Appendix B: Spectrum Calculation Worksheet

		UTILITIES SPECTRUM REQUIREMENTS, 1998-2010.										
			R.E.RUTHENBERG									
TABLE 1												
Vertical Market	**1995 Total Employees- LA County**	**1995 Total Employees- U.S.**	**Radio Penetration %**	**1995 Total LA County Radios**	**1995 Total U.S. Radios**							
UTILITIES ONLY (	18918	757000	66%	12486	499620							
NOTE: The transceiver count for LA utilities is calculated by assuming the penetration (66%) is the same												
as for the penetration of the total of (utilities + telephone markets) in the county.												
TABLE 2												
				CURRENT SVCS				ADV SVCS PENETRATION			ADV SVCS #	RADIO UNITS
L.A. COUNTY RADIO USE FORECAST				GRWTH RATE				[% OF VOICE RADIO USERS]		2000 TOTAL	2000 TOTAL	2010 TOTAL
MARKET	1995 TOTAL	1995 TOTAL	PENETRATION	%	2000 TOTAL	2010 TOTAL	TYPE USER	W.B. DATA	VIDEO	W.B. DATA	VIDEO	W.B. DATA
	EMPLOYEES	RADIOS	%		RADIOS	RADIOS	H/M/L	%	%			
UTILITIES	18918	12486	66.0	4	14049	20797	H	27.33	17	384	239	5684
NOTES												
(1)THE 1995-2000 GROWTH RATE IS ASSUMED TO BE APPROXIMATELY 60% OF LONG TERM TO ACCOUNT FOR ASSUMED MARKET "CHILLING"												
DUE TO VARIOUS FACTORS INCLUDING USER UNCERTAINTY RELATIVE TO "REFARMING" FCC RESOLUTIONS, LICENSING FREEZES AND AUCTION												
ISSUES AT 800/900MHZ, COORDINATION POOL CONSOLIDATION RESOLUTIONS, DEVELOPMENT OF NEW COORDINATOR SOFTWARE AND INTER-												
COORDINATOR NETWORKS, ETC.												
(2)YEAR 2000 WB SERVICE PENETRATION IS ASSUMED AT 0.1 THAT OF YEAR 2010.												
TABLE 3												
SPECTRUM REQUIREMENTS CALCULATION												
YEAR 2000												
	ERLANGS/	# UNITS	SRC	COD	RATE	LOAD	REUSE	ERR	SPECTRUM	EFF. CHANNEL		
	UNIT		KBPS		B/S/HZ	%		%	MHZ	BW - KHZ		
VOICE	0.0242	14049	6	1	0.75	54.5	4	54	2.71	17.4		
DATA	0.00435	7025	6	1	0.75	54.5	4	54	0.24	17.4		
STAT/MESSAGE	0.0004	7025	6	1	0.75	54.5	4	54	0.02	17.4		
W.B. DATA	0.007	384	384	2	2	54.5	4	54	0.26	208.7		
VIDEO	0.012	239	384	2	2	54.5	4	54	0.27	208.7		
								SUB TOTAL	3.51			
NOTES							LESS	COMM SVCS	-0.30			
(1) THE ABOVE FACTORS ARE ESTIMATED FOR YEAR 2000, AND DEMONSTRATE LESS								TOTAL REQD	3.2			
TECHNOLOGY IMPROVEMENT THAN FOR YEAR 2010, OBVIOUSLY THE CASE.							LESS	EXISTING	2.24			
(2) DATA AND STATUS MESSAGE ARE ESTIMATED AT A PENETRATION OF HALF VOICE.								FINAL TOTAL	1.0			
(3) REUSE FACTOR FOR CURRENT SERVICES IS HIGHER THAN YEAR 2010 AND REPRESENTS												
THE MORE CROWDED, REDUCED COMMUNICATIONS QUALITY OF TODAYS PLMR SERVICE.												

TABLE 4										
SPECTRUM REQUIREMENTS CALCULATION										
YEAR 2004										
	ERLANGS/	# UNITS	SRC	COD	RATE	LOAD	REUSE	ERR	SPECTRUM	EFF. CHANNEL
	UNIT		KBPS		B/S/HZ	%		%	MHZ	BW - KHZ
VOICE	0.026144	15508	6	1	0.8	54.5	4	54	3.03	16.3
DATA	0.007582	7754	6	1	0.8	54.5	4	54	0.44	16.3
STAT/MESSAGE	0.0004	7754	6	1	0.8	54.5	4	54	0.02	16.3
W.B. DATA	0.0126	424	384	2	2.2	54.5	4	54	0.46	189.7
VIDEO	0.0216	264	384	2	2.2	54.5	4	54	0.50	189.7
								SUB TOTAL	4.46	
NOTES							LESS	COMM SVCS	-0.35	
(1) THE ABOVE FACTORS ARE ESTIMATED FOR YEAR 2000, AND DEMONSTRATE LESS								TOTAL REQD	4.1	
TECHNOLOGY IMPROVEMENT THAN FOR YEAR 2010, OBVIOUSLY THE CASE.							LESS	EXISTING	2.24	
(2) DATA AND STATUS MESSAGE ARE ESTIMATED AT A PENETRATION OF HALF VOICE.								FINAL TOTAL	1.9	
(3) REUSE FACTOR FOR CURRENT SERVICES IS HIGHER THAN YEAR 2010 AND REPRESENTS										
THE MORE CROWDED, REDUCED COMMUNICATIONS QUALITY OF TODAYS PLMR SERVICE.										

TABLE 5										
SPECTRUM REQUIREMENTS CALCULATION										
YEAR 2010										
	ERLANGS/	# UNITS	SRC	COD	RATE	LOAD	REUSE	ERR	SPECTRUM	EFF. CHANNEL
	UNIT		KBPS		B/S/HZ	%		%	MHZ	BW - KHZ
VOICE	0.035	20797	6	1.25	1	54.5	3.5	50	3.66	9.60
DATA	0.0087	10398	6	1	1.5	54.5	3.5	50	0.38	8.0
STAT/MESSAGE	0.0004	10398	6	1	1.5	54.5	3.5	50	0.02	8.0
W.B. DATA	0.014	5684	384	3	3.5	54.5	4	50	2.67	73.1
VIDEO	0.024	3535	384	3	3.5	54.5	4	50	2.85	73.1
								SUB TOTAL	9.58	
NOTES							LESS	COMM SVCS	-1.08	
(1) ESTIMATES UTILIZE PSWAC TECHNOLOGY FACTORS, MODIFIED FOR NON-PS CONDITIONS.								TOTAL REQD	8.5	
(2) DATA AND STATUS MESSAGE ARE ESTIMATED AT A PENETRATION OF HALF VOICE.							LESS	EXISTING	2.24	
(3) REUSE FACTOR FOR CURRENT SERVICES ARE ASSUMED SLIGHTLY HIGHER								FINAL TOTAL	6.3	
THAN PSWAC DUE TO TO ASSUMED MORE CROWDED CONDITIONS THAN P.S.,										
YET LOWER THAN YEAR 2000 BASED ON ASSUMPTIONS OF BOTH IMPROVED										
COMMUNICATIONS QUALITY YET LESS REUSE DUE TO INTERFERENCE BETWEEN NARROW CHANNELS.										

TABLE 5							
ADDITIONAL SPECTRUM REQUIREMENT SUMMARY							
	*********	REQUIREME***********					
YEAR	NB VOICE/ DATA - MHZ	WB DATA MHZ	VIDEO MHZ	TOTAL REQD MHZ	CURRENT SPECTRUM	TOTAL ADDTL REQUIRED SPECTRUM (MHZ)	ADDTL REQMNT, % of LMCC TOTAL
1995	2.24			2.24	2.24	0.00	
2000	2.68	0.26	0.27	3.21	2.24	0.97	6.5
2004	3.15	0.46	0.50	4.11	2.24	1.87	4.2
2010	3.25	2.40	2.85	8.50	2.24	6.26	5.0

Note: For calculation purposes, the "Required spectrum" for year 1995 is assumed to be zero, even though that is not necessarily true i.e. the service was (and still is) more than likely already heavilily congested.

DEFINITION: Utilities, as used herein:

90.63 (a) (Power Radio Service) describes "Power" entities as those engaged in (1) The generation, transmission or distribution of electrical energy for use by the general public or by the members of a cooperative; (2) The distribution of manufactured or natural gas by means of pipe line, for use by the general public or by the members of a cooperative organization, or, in a combination of that activity with the production, transmission or storage of manufactured or natural gas preparatory to such distribution; (3) The distribution of steam by means of pipeline or, of water by means of pipeline, canal, or open ditch, for use by the general public or by the members of a cooperative organization, or in a combination of that activity with the collection, transmission, storage, or purification of water or the generation of steam preparatory to such distribution; or (4) The providing of a supporting service by a corporation directly related to activities of its parent corporation....

Appendix C: USAT Steering Committee

First Name	Last Name	Affiliation
Klaus	Bender	Itron
Jerry	Briggs	Texas Utilities
Jeff	Cohen	Wilkinson, Barker, Knauer & Quinn/Cellnet
Allen	Davidson	Motorola
Tom	Goode	UTC
Carl	Greenway	Kansas City Power & Light Company
Dennis	Guard	UTC
Ralph	Haller	Fox Ridge Communications
John	Howell	Houston Lighting & Power Company
Al	Ittner	Motorola
Dick	Krause	Southern California Edison
John	Krupcale	Niagara Mohawk Power Corporation
Ed	Leisten	Motorola
John	Ng	Potomac Electric Power Company
Jerry	Obrist	Lincoln Water System
John	Ratliff	Cellnet
Ross	Ruthenberg	Motorola
Gary	Schwartz	Rappahannock Electric Cooperative
Jeff	Sheldon	UTC
Robert	Speidel	Ericsson
Pat	Spilman	Basin Telecommunications
Sean	Stokes	UTC
George	Stoll	Utilities Telecommunications Consulting Group
Karnel	Thomas	UTC
Al	Vazquez	Southern California Edison
Steve	Via	American Water Works
Dick	Weber	Basin Telecommunications
Tom	Whaley	Motorola
Brian	Wolf	Basin Telecommunications